Claims

1. Method for storing underground ecologically dangerous substances, which are located in containers and/or are open products containing such substances, as well as many other specific storage objects,
characterised in that
the storage takes place in deep boreholes and/or in shafts with borehole pipes which are sealed and into which the storage objects are brought through a lock, for example through lock devices known per se, the storage objects being arranged beforehand in technological secondary containers which are open at the bottom and represent structurally altered caissons, and thereafter these caissons, with the storage objects arranged in them, are placed the one on top of the other inside a pipe liner in the borehole avoiding conventional mechanical devices such as shaft elevators or lifts, and **in that** for operating all the known underground objects, preferably for all the necessary loading and unloading operations inside the borehole, a gas-hydrodynamic complex system is used with the aid of which structural elements going into the stock of this system and functional subsystems of this system are controlled remotely.

2. Method according to claim 1,
characterised in that
the gas-hydrodynamic complex system combines functionally three main system groups, specifically a hydraulic subsystem and a gas subsystem which are both provided with devices which are known per se but perfected, and a third subsystem which includes the lock device of the

type known per se or of a structurally perfected type provided for specific storage objects and also the above-mentioned technological caissons which, however, are designed with a specific special structural feature as a result of which the functionally most important action is carried out with the aid of the created gas-hydrodynamic complex system in the caissons, namely a target calculation in which the value of the positive buoyancy of the caissons used with the storage objects arranged in them is set by remote control, this action relating in principle to a random depth of the following forced immersion into a random fluid medium with which the borehole has been previously filled.

3. Method according to claims 1 and 2,
characterised in that

- with the aid of the gas-hydrodynamic system, the remote-controlled loading of the borehole storage site with the technological caissons takes place in principle in that the entire interior of the sealed borehole pipe liner, even up to where it emerges from the hydraulic subsystem, is filled with some technological fluid, for example with water or some other fluid which is especially most compatible chemically with the stored substances and materials which are used overall in the construction of the storage site,
- thereafter, with the aid of the above-mentioned third subsystem, the lower caisson with the special feature is first loaded via the lock device into the borehole, which is flooded by the fluid,

- no storage objects are arranged in this lower caisson and it is constructed to retain the positive buoyancy right up to maximum immersion directly to the bottom of the borehole,
- thereafter this lower caisson is plunged by this means into the technological fluid in the borehole,
- on top of it is placed, again with the aid of the lock device having an appropriate ram, the second technological caisson with storage objects in it and with a relatively lower value, calculated for it, of the original positive buoyancy,
- the third caisson is placed in a similar manner etc. until the entire calculated set of caissons has been submerged in the technological fluid located inside the borehole and correspondingly the technological fluid displaced from the borehole has been led into an external collector of the hydraulic subsystem or into some other, for example adjoining, borehole which is being prepared for future loading or is located in the unloading area,
- in the course of the above-mentioned actions, the reduced, summary, positive buoyancy, arising according to the submersion of the caissons, of the entire vertical caisson assembly provided is constantly monitored and then the buoyancy value is obtained by calculation with the aid of the monitoring,
- then the gas subsystem starts,
- into the calculated depths inside the borehole, air or some other chemically preferred gas for the storage objects,

preferably nitrogen, argon or helium, is led through the layer of technological fluid into the lower caisson, and

- with the above-mentioned inter-connected actions, the in-put positive buoyancy of the entire vertical caisson assembly provided is maintained according to its submersion until the lower caisson strikes the borehole bottom and thus the calculated remote-controlled loading of the borehole with the caissons having the storage objects in them is terminated.

4. Method according to claim 1 or 2,

characterised in that

- for creating a condition of "dry" storage in the borehole storage site, on termination of the loading of the deep borehole, the mouth of the borehole is hermetically sealed with an appropriate blocking device, using the gas-hydrodynamic control system,
- **in that** gas is led into the interior of the pipe liner from the gas subsystem under such pressure that the removal of the technological fluid used from the interior of the borehole is guaranteed by means of "pressing out" to the outside through peripheral pipe ducts which are secured for this purpose to the lower base portion of the borehole, communicating vessels of sorts being produced,
- after this final removal of the technological fluid into the external collectors, these peripheral pipe ducts are also hermetically sealed, and

- **in that**, furthermore, inside the storage borehole a technologically recommended excess pressure is generated of that gas which is also selected for technological reasons for the completed formation of the appropriately "dry" protective atmosphere in the borehole storage site.

5. Method according to claim 1 or 2,
characterised in that
the processes of unloading from the borehole storage site the caissons containing the storage objects, using the gas-hydrodynamic system, are realised in the following manner:

- first, in the borehole, the pressure of the gas protective atmosphere previously established in it is lowered to the calculated value, preferably to the external atmospheric pressure,
- thereafter, from the hydraulic subsystem the borehole is filled with the technological fluid in its base portion, for which purpose the peripheral pipe ducts are used, and
- simultaneously, also from the base portion, sparging gas is led from the gas subsystem into the lower caisson which is so designed that the gas also flows in turn into all the caissons arranged on top, by which means, in the entire vertical caisson assembly, that calculated positive buoyancy is created as a result of which the controlled general rising of the entire caisson column up to the upper mouth of the borehole and/or up to the entrance into the lock device is also caused, out of which the caissons are guided cyclically by means of appropriate gripping

mechanisms in control rooms, and by which means, inside the underground bunker, an equipment check of the caissons and the storage objects located in them takes place for formulating a summary decision or for extending the deep storage (for some of them), for example in the adjoining borehole storage site or for delivering storage objects to be removed from the bunker according to a corresponding stipulation, preferably for technological processing.

6. Method according to claim 1 or 2,
characterised in that
in those cases in which heat absolutely must be dissipated from the storage objects, for example from the radioactive waste or from the spent fuel elements and also from weapons-grade plutonium and other radioactive materials, in the construction of the borehole storage site the known physical effect of "super heat conductivity" is realised and **in that**, inside the borehole is arranged a so-called heat pipe with heat dissipation onto the inner wall of the upper region of the pipe liner and/or through its walls onto external heat exchangers and correspondingly the necessary gas pressure for this is set in the protective atmosphere inside the borehole.

7. Method according to claim 1 or 2,
characterised in that
particularly dangerous storage objects, for example nuclear fission materials, are loaded into the technological caissons which are containers of the most secure type, for which purpose the elongated cylindrical containers are used which

are disclosed in the patent RU 2193799 entitled "Storage sites of fission materials".

8. Method according to claim 1 or 2,
characterised in that
the accomplished loading of the storage objects, for example the nuclear fission materials, is protected against the external physical influence not only with the appropriate submersion into the borehole but also with the use of protective materials known per se, preferably lithium hydride, gadolinium, lead and others, in the loading of the upper caissons, and **in that** on this basis the so-called shadow protection against external neutron radiation and/or hard gamma radiation is created.

9. Method according to claim 1 or 2,
characterised in that
inside the underground bunker used, two or more borehole storage sites are created, the lock devices of which are united by the transport corridors with a general robot chamber for the remote-controlled overall equipment check for the caissons and the storage objects contained in same, as well as with a general zone for receiving into the underground bunker and for delivering from this bunker the caissons having the storage objects.

10. Method according to claim 1 or 2,
characterised in that
for the practically complete exclusion of unauthorised access to the storage objects which are located in the borehole storage sites, after their loading and the hermetic sealing of the

borehole mouth, the lock devices used are dismantled and removed from the underground bunker to be accommodated in an external central store, possibly being temporarily accommodated in other uniform storage sites for work processes to be carried out, and **in that** the gas-hydrodynamic guiding system is arranged on a vehicle, preferably on a car transport trailer, which is moved to the location of the actual borehole storage sites only for the time needed to carry out the sanctioned scheduled work, and is then also moved to the above-mentioned central store.

11. Method according to claim 1 or 2,
characterised in that
when a borehole storage site of relatively small depth is used, it is possible to use, instead of the above-mentioned caissons operated with sparging gas, pontoon-like airtight floating tanks to which the storage objects are fastened, all the procedures of loading and unloading the borehole then being carried out with limited use of the above-mentioned gas subsystem only for "pressing" the technological fluid out of the borehole in the case of "dry" storage.

12. Method according to claim 1 or 2,
characterised in that
for reducing the value of the force which is necessary for plunging the caissons or floating pontoons into the technological fluid of the borehole storage site, some of the above-mentioned fluid is removed externally from the borehole using an appropriate pump, the amount preferably corresponding to the volume of the next object plunging into this fluid.

13. Method according to claim 1 or 2,
characterised in that
the value of the general positive buoyancy, which is produced by the vertical assembly of the caissons and which naturally reduces with increasing immersion in the technological fluid, is measured by means of calculating remotely the value of the force which is preferably produced from the side with a ram of the lock device in the course of the vertical assembly of the caissons created during the above-mentioned cyclical submersion.

14. Method according to claim 1 or 2,
characterised in that
for carrying out the remote-controlled monitoring of the borehole storage site, after termination of the sanctioned work on same, the underground bunker is hermetically sealed and in said bunker as well as directly in the borehole, a recommended excess gas pressure is generated technologically and structurally, the provided level of which is held and then continues to be automatically maintained, preferably via radio channels from a central protection support point.

15. Apparatus for accomplishing the method according to one of claims 1 to 14 for storing underground preferably ecologically dangerous substances,
characterised in that
it is equipped with a borehole and its borehole pipe (column) or with a shaft column which is provided with a corresponding pipe column or contains a plurality of individual boreholes with their pipe towers fixed into its walls, in all

cases the base of the borehole pipes being hermetically sealable and there being fastened over the mouth of each borehole an underground bunker in which the lock device for carrying out the external loading and unloading is arranged with the technological secondary containers used, in the form of caissons, in which the storage objects themselves are accommodated and **in that** inside the borehole, in addition to its borehole pipe there is fastened a technological pipe column, on the outer side of which pipe ducts are secured, of which some are connected to the hydraulic subsystem and the remainder to the gas subsystem, including accompanying structural elements which are constituent parts of the complex gas-hydrodynamic system created.

16. Apparatus according to claim 15,
characterised in that
the gas-hydraulic complex system for the remote-controlled work in the storage sites comprises three main subsystems, namely the hydraulic subsystem and the gas subsystem which are both equipped with known functional elements, especially with hydraulic pumps and gas compressors having appropriate valve fittings, are fastened outside the underground bunker, for example on a car trailer, and are connected to the general control complex only for the duration of the sanctioned work, as well as a third subsystem which is fastened inside the borehole storage site and includes the lock device of the type known per se or of a type matched to the actual storage objects as well as a set of technological secondary containers in the form of caissons,

which have special features, however, and in which the storage objects are directly arranged.

17. Apparatus according to claim 15 or 16,
characterised in that
the technological secondary containers in the form of caissons as part of the above-mentioned third functional subsystem are so designed that each caisson is provided with an upper lid having openings, to which inner injection pipes are connected from below in an airtight manner, the lower cross-section of which is arranged in front of the lower lid of the caisson, this lower lid being itself also provided with openings, the centres of the openings lying the one above the other vertically with respect to the centres of the openings on the upper lid of the caisson and the storage objects being secured between these lids, which are connected to a cylindrical outer wall, inside the above-mentioned caisson.

18. Apparatus according to claim 15 or 16,
characterised in that
the lowermost caisson is provided with the greatest calculated buoyancy, the positive importance of which is guaranteed structurally at all levels of its submersion until it rests on the bottom of the borehole, and **in that** no storage objects are secured in this caisson and it is provided with a central support platform and a hydraulic damper.

19. Apparatus according to claim 15 or 16,
characterised in that
in the base region of the borehole, some of the number of pipe ducts which are fastened on the

technological borehole pipe column and connected in their upper region to the hydraulic subsystem, are secured by their lower ends to the base plane of the pipe liner and form with the inner circumference of the borehole communicating vessels of sorts, and **in that** the other pipe ducts, which are connected to the external gas subsystem, are provided at their lower ends with angular apertures (nozzles) for the sparging gas supplied in a jet through the technological fluid to the lower caisson, the gas being fed through this caisson continuously into all the higher arranged caissons having storage objects, in which process particularly deep boreholes are formed with a plurality of intermediate zones for blowing gas through the lower caisson, which are distributed in the depth of the borehole, and these zones are equipped with corresponding gas ducts also having lower angular apertures (nozzles) for a similar way of supplying the sparging gas to that in the lower caisson, for example during its submersion and movement towards precisely these intermediate zones.

20. Device according to claim 15 or 16,
characterised in that
one or more pipe ducts, which are connected to the hydraulic subsystem, are connected to a separate pumping unit for periodically pumping the technological fluid out of the borehole from the submersion plane, which is less than the size of the barometric column of this fluid.

21. Apparatus according to claim 15 or 16,
characterised in that

in the plane of the borehole mouth, in front of its sealed upper blocking closure, sliding supports, preferably some type of one-sided latch arrangements, are secured to prevent the uncontrollable rising of the loaded upper caisson and of the entire caisson assembly into the region of the arrangement of the lower blocking closure of the lock device.